The Andhra Agric. J 64 (1): 187-193, 2017

Shelf Life Extension of Papaya Fruit by Shrink Wrapping

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ABSTRACT

Papaya (*Carica papaya*) is a popular and economically important fruit of tropical and subtropical countries. Papaya fruits are rich in enzymes called papain and chymopapain. Marketing of fresh papaya is a great problem because of its short post-harvest life, which leads to high post-harvest losses. The focus of this research was to study the effect of shrink wrapping on physico-chemical properties and shelf life extension of papaya. Two sets of fruits (wrapped and unwrapped) were held at ambient (32-39^{0}C, 72-83% RH) and refrigerated conditions (10-12^{0}C, 90-95% RH) throughout the storage period. Weight loss, pH, moisture content, TSS, vitamin C, vitamin A, proteins, carbohydrates were evaluated at an interval of 4 days. Changes in moisture content, protein, vitamin C, carbohydrates of the shrink-wrapped fruits were lower than that of un wrapped fruits during storage. Papaya fruits stored at room temperature, refrigeration, shrink wrapped and shrink wrap + refrigeration had a shelf life of 10, 14, 13, and 19 days respectively. Results proved that shrink wrapped papaya at refrigerated conditions had longer storage period compared to other storage conditions.

Key words: *Papaya, Shrink wrapping,Vitamin C, Weight loss.*

Papaya fruits are rich in enzymes called papain and chymopapain that break down the proteins into amino acids and therefore help in digestion. Papaya is rich in vitamin A, vitamin C, vitamin B, folates, minerals and fiber. It is also rich in antioxidants, low in sodium and calories, high in potassium and no cholesterol (USDA, 2013*)*. India is the largest producer of papaya in the world with 5381727 MT tones production and with productivity of 40.7 MT/ ha (FAO, 2014) while Andhra Pradesh is the largest producer in India with 1651.96 MT with productivity 80 MT/ha (NHB, 2014). Exporting papayas is limited due to difficulties in storing them and their susceptibility to bruising. Only 0.08% of domestic production is exported and the rest is consumed within the country. Total 3329 MT of papaya was exported from India during the period 2012-13(APEDA, 2014*)*.

Postharvest losses of tropical fruits are a serious problem because of rapid deterioration during handling, transport and storage (Yahia, 1998).The perishable nature of papaya is a major drawback for transport of fruits to distant places and storage during glut in the market. Papaya fruits soften rapidly at room temperature. Fruits face tremendous loss due to old-fashioned preservation practice and ignorance about preservation strategies. Different storage methods used to preserve papaya include low temperature storage, controlled atmospheric storage, chemical preservatives, wax coatings and plastic film wraps. But there are many reports that papaya in refrigerated storage is susceptible to fungal decay. Chemical preservatives can have dangerous effects on health such as kidney and liver damages, various types of cancers etc. Hence there is a need to develop suitable cheaper storage techniques. So processing of papaya has attained greater significance.

The greatest advantage by individual shrink wrapping is its ability to control moisture loss to a great extent. The film forms a barrier that markedly increases the resistance to water vapor. The transpiration rate can be reduced 5 to 20 times by individual seal packing of fruit using selectively permeable films. Merits of shrink wrapping also includes easy and user friendly technique which can be very well adopted by marginal farmers and entrepreneurs, wrapped produce looks attractive, hygienic and free from dust and dirt, easy to handle shrink-wrapped fruits and vegetables during storage or transportation, avoids secondary infection, which is important for long term storage. Hence research

was undertaken to study effect of shrink wrapping on shelf life, physico-chemical, organoleptic properties of Papaya.

Muhammad and Ding (2013) used paper, shrink film wrap and Xtend film to study the effect of shelf line of papaya. Wrapped fruits were placed at 12±2 α and 85% RH for 3 weeks. Shrink film wrapped fruit had better quality and well-preserved compared to the other two packaging materials. Baskar (2005) reported that the storage life of papaya was extended to 2, 3 and 4 weeks at RT, 18 α and 13 α respectively followed by 3 to 4 days for ripening after unpacking the fruits. Shrink wrapping prevented the development of chilling injury during 4 weeks of storage at 13 α where as non wrapped fruits exhibited chilling injury symptoms after 2 weeks of storage.

MATERIAL AND METHODS

Freshly harvested, healthy and matured papaya fruits (Variety: Taiwan Red Lady) obtained from papaya farm were selected, the study was conducted at College of Agricultural Engineering, Bapatla. Fruits were washed with fresh water and stored under ambient condition **(**Temp: 32-39°C; RH: 72-83%) and another sample of fruits were stored under refrigeration condition (Temp: 12-15°C; RH: 90-95%). Data on weight loss, pH, TSS, carbohydrates, ascorbic acid content, protein and vitamin A were recorded at an interval of 4 days for 20 days.

Determination of Shape and Size:

Three axial dimensions namely as length, width and cross length were measured using a digital calipers with sensitivity of 0.01 mm. Dimension 'L' is the main (length) diameter, '*W'* (width) is the longest dimension perpendicular to '*L'*(Kheiralipour *et al*., 2008).

Shrink Wrapping of papaya fruits

Individual papaya fruits were enclosed in heat shrinkable film (Polyolefin shrink film, 15 μ). A sealer was used to loosely pack the films around the fruits before wrapping in heat shrink tunnel. The fruits sealed in the film were then passed through a heat shrink tunnel of mini shrink wrapping machine (model: PP Mini) on a moving belt at 220°C for 10 seconds with belt speed of 6 cm/s to form a tight wrap on the fruit surface.

Chemical Analysis of Papaya Fruits

Estimation of proteins: Protein is estimated by Lowry's method (Thimmaiah, 1999).

Estimation of carbohydrates: The amount of total soluble sugars was estimated using anthrone method (Thimmaiah, 1999).

Estimation of vitamin A: Vitamin A content was estimated by the method given by Srivastava and Sanjeev kumar, 2012.

Estimation of ascorbic acid (Vitamin-C): Estimation of ascorbic acid was by volumetric and colorimetric methods (Thimmaiah, 1999)

Estimation of Total soluble solids: Total soluble solids of the samples was measured by placing a drop of the juice sample on the prism of the Hand refractrometer (Srivastava & Sanjeev Kumar, 1994).

Estimation of pH: The pH measurement was performed using a pH meter. (Srivastava & Sanjeev Kumar, 1994)

Estimation of Moisture content: Moisture content (% w.b) of the papaya was determined by hot air-oven method (AOAC, 2005).

Sensory analysis of papaya fruit:

The hedonic rating was used to measure the consumer acceptability of food products. The samples were served to the panelist at one session and were asked to rate the peel color, taste, aroma and overall acceptability of the product on a scale. Organoleptic quality of papaya was determined with the help of a 15 member consumer panel using a 9-point hedonic scale.

RESULTS AND DISCUSSION

Effect of shrink wrapping, storage temperatures on shelf life of papaya and the changes in physico-chemical properties of papaya during storage was reported.

Effect of Shrink wrapping on Weight Loss:

The weight loss of unwrapped, and shrink wrapped fruits at ambient temperature gradually increased to 29.8%, 10.21% respectively by 12th day. Whereas at refrigeration temperature the weight loss of unwrapped, shrink wrapped fruits

Fig. 1. Effect of storage method on weight loss.

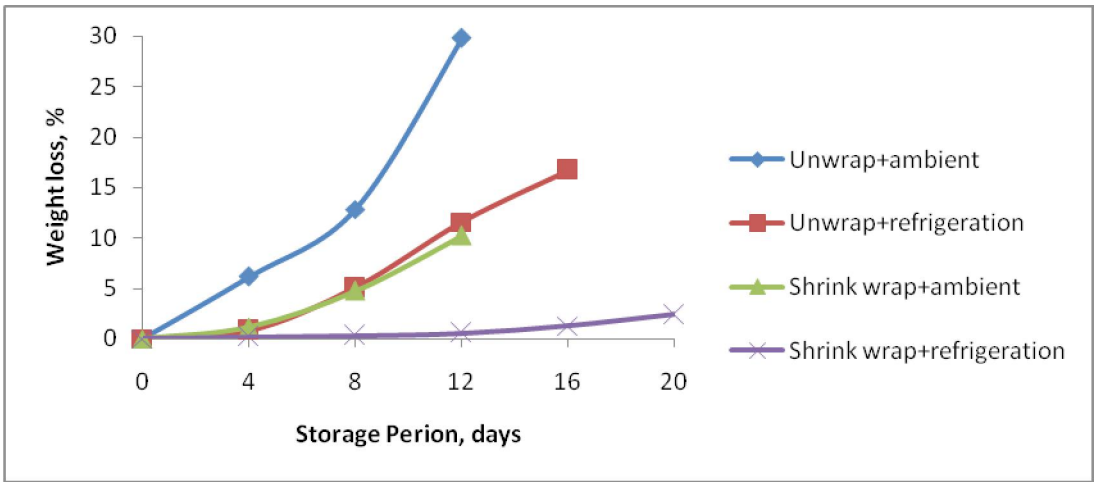


Fig. 2.Varaition in p^H of stored papaya.

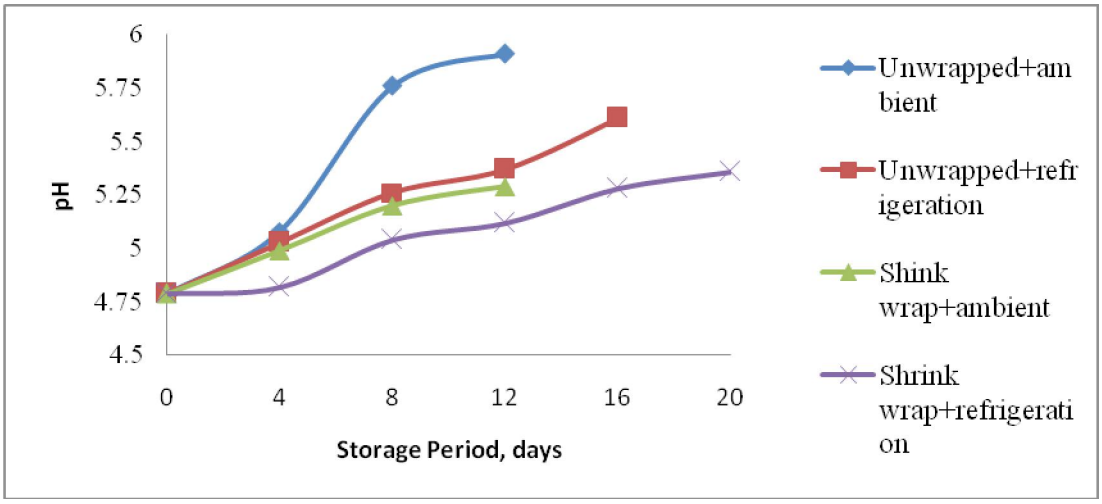


Fig. 3.Variation in TSS during papaya storage.

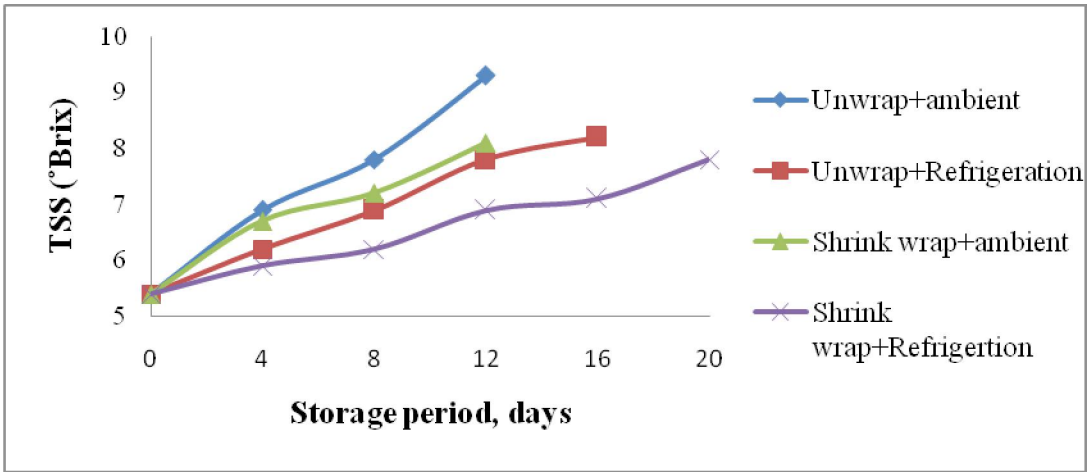


Fig. 4.Variation in moisture content of stored papaya.

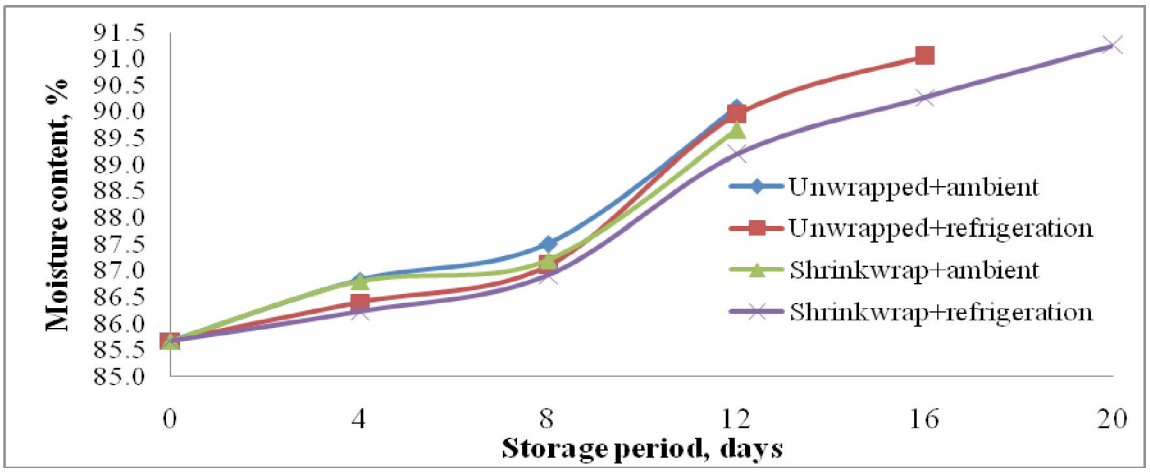


Fig. 5.Variation in Vitamin C during storage period.

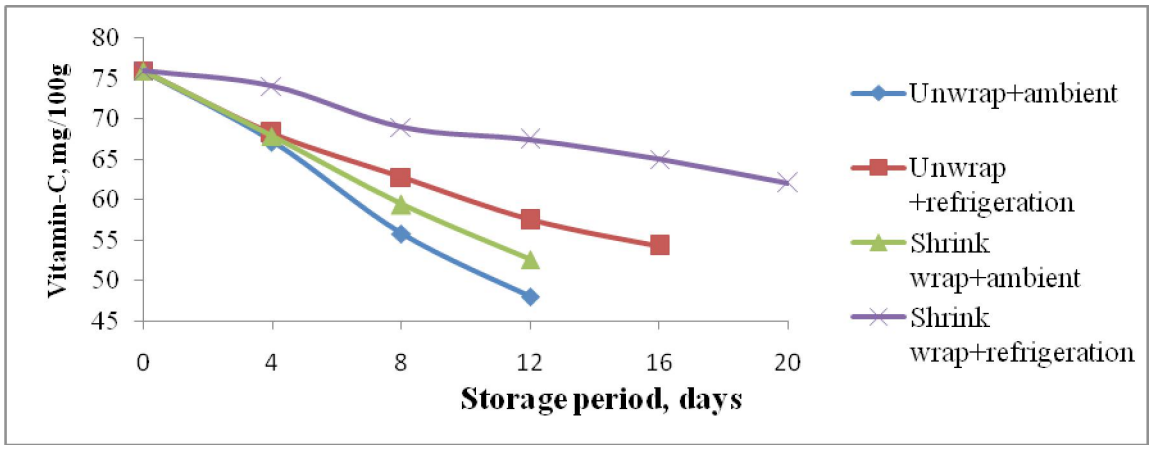


Fig. 6.Variation in vitamin-A during papaya storage.

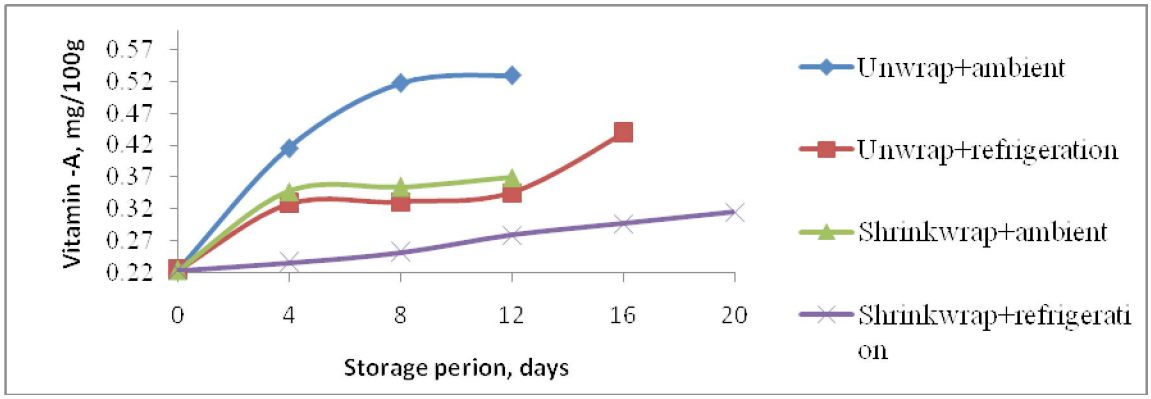


Fig. 7.Variation in Carbohydrate content of stored papaya.

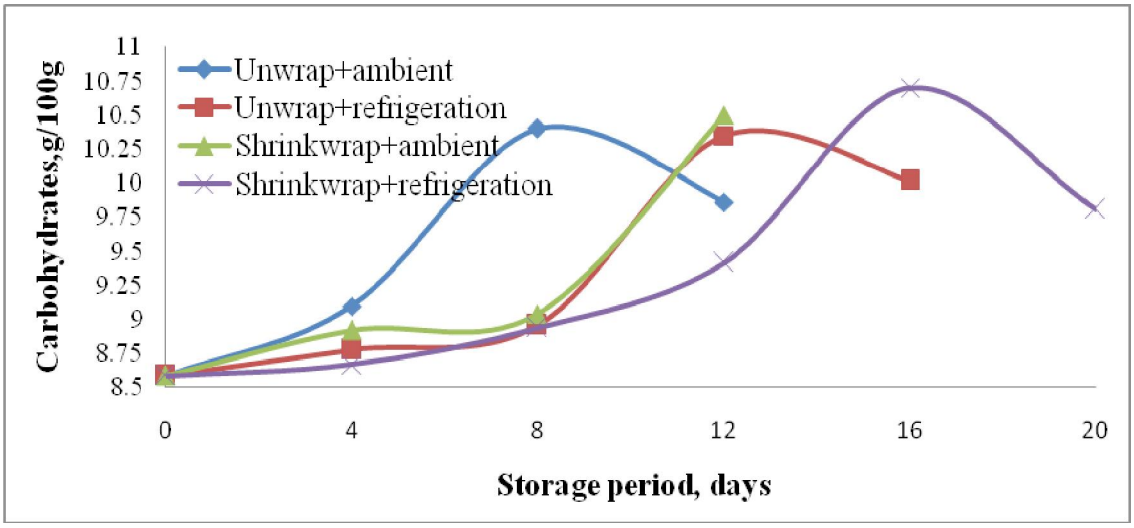
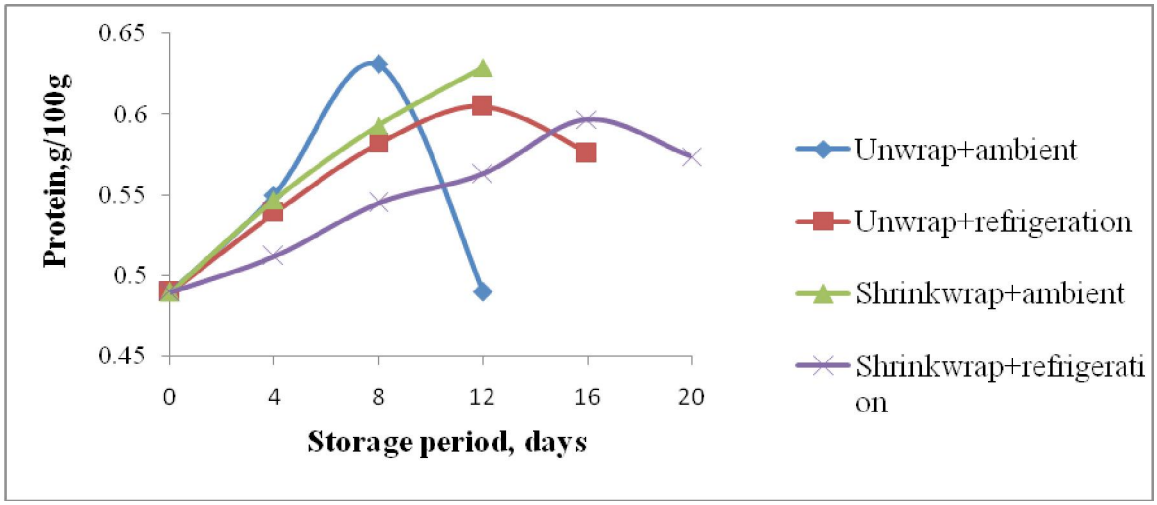


Fig. 8.Variation in Protein content of stored papaya.



increased to 16.73% (16th day), 2.5% (20th day) respectively. From Fig. 1 it was evident that the weight loss in wrapped fruit at refrigeration was minute. The reduction in weight loss in fruits may be attributed to higher respiration rates due to metabolic activities.

Effect of shrink wrapping on pH

The pH of freshly harvested fruit was 4.79 and increased by 5.91, 5.29 in unwrapped, shrink wrapped fruits at ambient temperature respectively by 12th day. Whereas, at refrigeration temperature in unwrapped, shrink wrapped fruits, it was increased by 5.61 (16th day), 5.36 (20th day) respectively. Shrink wrapping lowered the changes in pH, effectively delaying fruit ripening (Fig. 2). This is due to the modification in internal atmosphere. The organic acids present in papaya are largely citric and malic acids. The increase in pH during storage was due to metabolic processes of the fruit that resulted in a decrease of organic acids.

Effect of shrink wrapping on Total soluble solids (TSS)

Freshly harvested fruits had TSS of 5.4°Brix. It was increased to 9.3, 8.1°Brix at ambient temperature in unwrapped and shrink wrapped fruits respectively by 12th day. At refrigeration temperature, TSS of unwrapped fruits was increased by 8.2°Brix (16th day) and to 7.9 ^{0} Brix (20th day) for shrink wrapped fruits. The

increase in TSS of papaya fruits was mainly due to the progressive boost in free sugars of fruit during storage period (Fig. 3). Shrink wrapped fruits retarded TSS development because wrapping decreases the respiration and eventually catabolism of sugars.

Effect of shrink wrapping on Moisture content

The moisture content of freshly harvested papaya fruit was 85.67 %(w.b). The moisture content increased significantly to 90.08%, 89.66% respectively by 12th day for unwrapped, shrink wrapped fruits at ambient temperature. At refrigeration temperature unwrapped, shrink wrapped fruits increased to 91.05% (16th day), 91.25% (20th day) respectively (Fig.4). At low temperatures, invert sugars are cause for increase in moisture content of papaya fruits.

Effect of shrink wrapping on Vitamin-C

Freshly harvested papaya fruits had the highest content of ascorbic acid (76 mg/100g). At ambient temperature it was decreased to 48 mg/ 100g, 52.6 mg/100g for unwrapped, shrink wrapped fruits respectively by 12th day. Whereas the unwrapped, shrink wrapped fruits at refrigeration temperature decreased to 54.3mg/100g (16th day), 62.1 mg/100g (20th day) respectively. The ascorbic acid content in the fruits decrease may be due to the utilization of organic acids in respiration process. Retention of vitamin-C content during extended storage of papaya fruits was of prime importance in post harvest handling as it would be rapidly lost during storage (Fig.5).

Effect of shrink wrapping on Vitamin-A

Vitamin A content of freshly harvested fruit was 0.223mg/100g. Vitamin A content increased significantly to 0.529mg/100g, 0.369mg/100g by 12th day for unwrapped, shrink wrapped fruits respectively at ambient temperature. For unwrapped, shrink wrapped fruits at refrigeration temperature it was increased to 0.439mg/100g (16th day), 0.297mg/100g (20th day) respectively. Unwrapped fruits at ambient temperature had the highest vitamin A while freshly harvested fruits had the lowest (Fig.6). As the fruit ripened slowly vitamin A content also increased slowly. Carotenoid content had increased with maturation and ripeness (Lee and Kader, 2000).

Effect of shrink wrapping on Carbohydrates

Freshly harvested papaya fruit had the carbohydrates content of 8.59g/100g. Unwrapped fruits at ambient temperature increased to 10.4g/ 100g upto 8th day and then decreased to 9.86g/100g by 12th day, whereas the unwrapped fruit at refrigeration increased to 10.365g/100g up to 12th day and then decreased to 10.02g/100g by 16th day. The shrink wrap fruits at ambient increased to 10.5g/ 100g by 12th day and the shrink wrap fruit at refrigeration temperature increased to 10.7g/100g till 16th day and then decreased to 9.81 by 20th day. Carbohydrates reached to a peak stage when it was fully ripened and decreased as it degrades (Fig. 7). During ripening, starch and sucrose are converted into glucose, which is the main substrate utilize in the respiration.

Effect of shrink wrapping on Protein

The protein content of freshly harvested fruit was 0.49g/100g. From Fig.8, it was observed that the protein content in the unwrapped fruits at refrigeration temperature was increased to 0.631g/ 100 g upto 8th day and then decreased to 0.496g/ 100g by 12th day, whereas the shrink wrapped fruits at ambient temperature increased to 0.629g/100 g by 12th day. Wrapped fruits at refrigeration increased to 0.605g /100g upto 12th day and then decreased to 0.576g/100g, whereas the shrink wrapped fruit at refrigeration temperature increased to 0.597g/100g upto 16th day and then decreased to 0.574g/100g by 20th day. During the climacteric phase of respiration, there is a decrease in free amino acids which reflects an increase in protein synthesis, while during senescence, the level of free amino acids increases reflecting, breakdown of enzymes and decrease in meta bolic activity.

Sensory evaluation:

Color is one of the most important visual attributes of papaya. The bright green color papaya fruits changed to yellow color after storage period. Complete yellowness was found after 10, 12 days storage of unwrapped, shrink wrapped fruits respectively at ambient temperature, whereas green skin with well defined yellow stripe was found at 10, 13 days storage period of unwrapped, shrink wrapped fruits respectively at refrigeration temperature. Visual assessment is the first

impression and a key feature in the choice of the fruit. Surface color of papaya is one of the most important criteria in determining ripening of papaya. Color retention of shrink wrapped fruits was due to the delay in ripening of fruits. The modified atmosphere created by the shrink film retarded the ethylene production rate therefore, delaying ripening, chlorophyll degradation and caratenoids synthesis thus ultimately delaying color change of fruits.

Regarding taste, shrink wrapped fruits had some bitter taste compared to ambient until 8th day. After 8th day the fruits at ambient condition were degraded slowly and by the 12th day it degraded completely and were not fit for consumption. Aroma was relatively similar to fruits at all conditions. Overall acceptance was good for shrink wrapped fruit even on the 20th day.

Conclusion: Polyolefin shrink wrapped papaya fruits Shelf life of papaya was extended to 12 days under ambient storage condition (75-83% RH, 32-39 °C) and 19 days under refrigerated conditions (10-12°C, 90-95% RH).

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(Received on 18.01.2016 and revised on 09.06.2016)